IS 6848 (1979): Lead-acid Batteries for Train Lighting and Airconditioning Services [ETD 11: Secondary Cells and Batteries]

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Indian Standard

SPECIFICATION FOR LEAD-ACID BATTERIES FOR TRAIN LIGHTING AND AIRCONDITIONING SERVICES

(First Revision)

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Indian Standard

SPECIFICATION FOR LEAD-ACID BATTERIES FOR TRAIN LIGHTING AND AIRCONDITIONING SERVICES

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Indian Standard

SPECIFICATION FOR LEAD-ACID BATTERIES FOR TRAIN LIGHTING AND AIRCONDITIONING SERVICES

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 27 June 1979, after the draft finalized by the Secondary Cells and Batteries Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This revision of the standard has been undertaken in view of the latest development in this field. Some test methods have been so modified that they will facilitate the testing of batteries under conditions that are closer to the actual working conditions. Two additional capacity tests at 5 and 3 hour discharge rates have been added.

0.3 This standard deals with the lead-acid storage batteries used in train lighting and airconditioning services.

0.4 The batteries are required to meet the power demand of the lights, fans and airconditioning equipment of the coaches during halts or slow running.

0.5 The supplier shall furnish information on proformae given in Appendices A and B while submitting tender.

0.6 Appendix C describes the service tests for information. If this test is to be performed, it shall be agreed to between the supplier and the purchaser.

0.7 Unless otherwise specified by the purchaser, for each set of 12 cells of 24 V battery, 10 intercell connectors and 4 battery end-cell connectors along with their fasteners shall be supplied. For 56 cells of 110 V battery, 104 intercell connectors and 16 battery end-cell connectors along with their fasteners shall be supplied.

0.8 In the preparation of this standard assistance has been drawn from the following publications:

IEC Publication : 77 (1968) Rules for electric traction equipment. International Electrotechnical Commission.

IEC Publication : 95-1 (1972) Lead-acid starter batteries : Part I General requirements and methods of test. International Electrotechnical Commission.

0.9 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard covers the methods of tests, performance and other requirements of secondary lead-acid storage batteries working for train lighting and airconditioning services, in conjunction with axle driven generator on railway coaches.

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in IS : 1885 (Part VIII)-1965† and IS : 8320-1976‡, in addition to the following, shall apply.

2.1 Type Tests — Tests carried out to prove conformity with the requirements of this standard. These are intended to prove the general quality and design of a given type of battery.

2.2 Acceptance Tests — Tests carried out on samples selected from a lot for the purpose of verifying the acceptability of the lot.

2.3 *Lot* — All batteries of the same type, design and rating, manufactured by the same factory during the same period using the same process and materials.

2.3 Electrolyte — Aqueous solution of sulphuric acid, for ionic conduction and electrochemical reaction during passage of current through a cell.

2.4 Terminal Post (Lug) — A post (lug) of a cell or battery to which an internal electrical circuit is connected.

2.5 Float — A device for the purpose of indicating the level of electrolyte in the cell container.

2.6 Float Guide — A removable bush to facilitate an easy vertical movement of float stem.

2.7 Filling Plug — A removable plug for fitting into the filler-hole.

*Rules for rounding off numerical values (*revised*).

†Electrotechnical vocabulary: Part VIII Secondary cells and batteries.

‡General requirements and methods of test for lead-acid storage batteries.

3. MATERIALS AND CONSTRUCTION

3.1 Overall Dimensions and Masses — The maximum dimensions and mass of each cell shall not exceed the values given in Table 1 for respective capacities.

TABLE 1 CAPACITIES AND DIMENSIONS OF CELLS

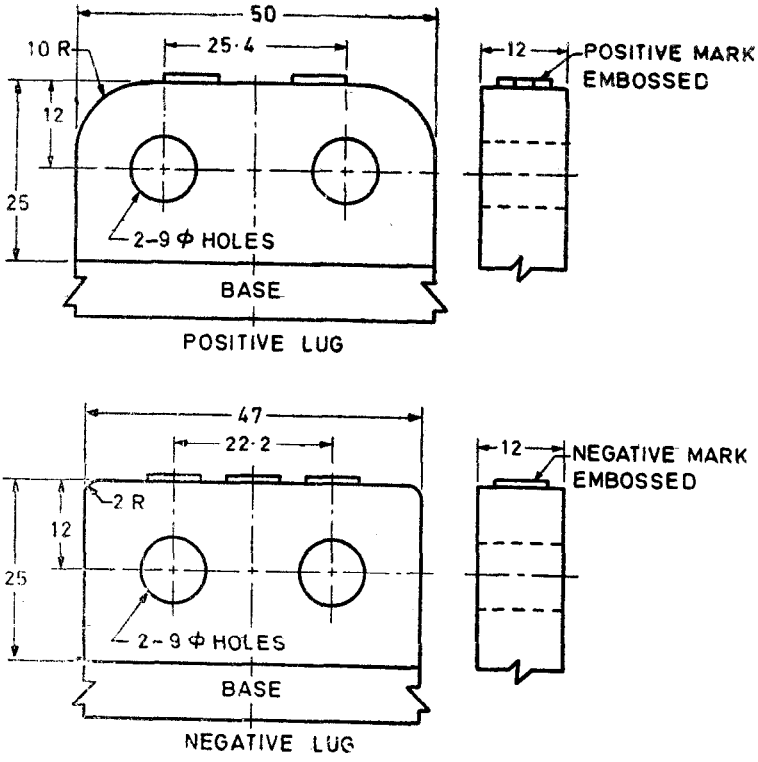
Sl No.	Capacity at 27°C	Rate of Discharge	Overall Maximum Dimensions of Cells			Maximum Mass with Electrolyte
			Length	Width	Height	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Ah		mm	mm	mm	kg
1	800	10-h	380	194	500	80
2	525	10-h	380	195	480	64
3	400	10-h	320	195	500	51
4	350	10-h	245	190	475	44
5	320	10-h	320	195	500	51
6	210	10-h	260	210	380	31
7	125	10-h	235	185	380	27

3.2 Terminal Posts and Connectors

3.2.1 Each cell shall be provided with positive and negative terminal posts made of lead alloy, each terminal post having two holes for intercell connection. The cells up to 540 Ah capacity shall have one positive and one negative terminal post whereas cells of 800 Ah capacity shall have two positive and two negative terminal posts. The positive terminal lugs shall have rounded edges and the negative terminal lugs shall have pointed edges, so as to be easily distinguishable (*see* Fig. 1).

3.2.2 For connecting terminal lugs of adjacent cells a pair of intercell connectors consisting of one inner and one outer strip as specified in Fig. 2A shall be used except for 800 Ah cells where 4 intercell connectors each consisting of one inner and one outer strip shall be used. The intercell connector shall be fastened on to the terminal lugs by means of fasteners as specified in Fig. 2B.

3.2.3 Each set of 12 cells of 24 V battery shall ordinarily be provided with two pairs of end-cell connectors as specified in Fig. 3 subject to stipulation in **0.7**. For each set of 56 cells of 110 V battery 16 end-cell connectors as specified in Fig. 3 shall be provided.



NOTE 1 — Dimensions intended to be standardized only have been shown, other dimensions are left to the manufacturer's choice.

NOTE 2 — Positive and negative shall be marked as + + and-N-respectively.

NOTE 3 — General tolerances ± 2·5 percent.

All dimensions in millimetres.

FIG. 1 CELL TERMINAL LUGS

3.3 Container and Lid

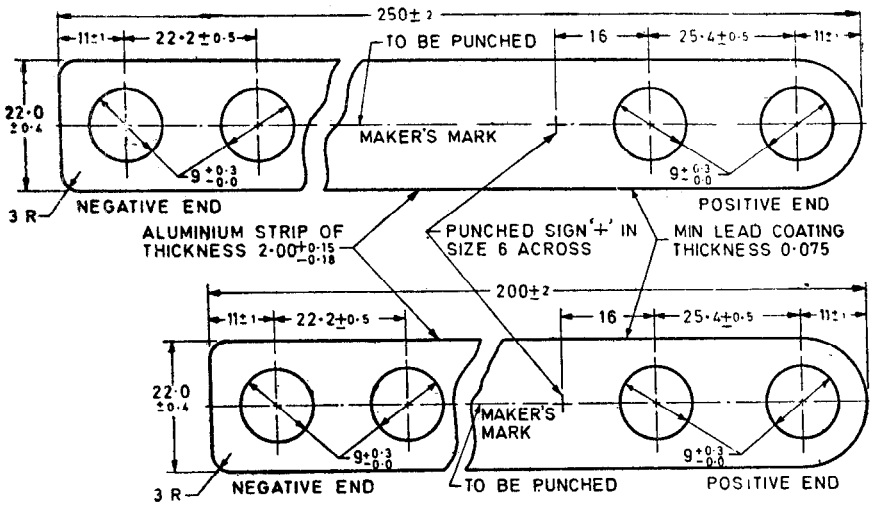
3.3.1 The cells shall be supplied in containers which shall conform to IS : 1146-1972*.

3.3.2 *Cell Lids* — Cell lids shall be either drop-on type together with suitable rubber gasket or of the deep-sealing type suitable for use with bituminous sealing compound, with close-fitting terminal post outlets and with vent-holes suitable for accommodating the float guide and filling plug vent-plugs.

*Specification for rubber and plastic containers for lead-acid storage batteries (*first revision*).

3.3.3 Suitable separator guard of acid resisting and insulating material shall be provided.

3.3.4 *Vent-Plug* — Each cell shall be provided with adequate means both for venting and for servicing of the electrolyte. The vent-plug shall be of the anti-splash type, preferably with more than one exit hole, and shall allow the gases to escape freely but shall effectively prevent acid particles or spray from coming out. On removal of vent-plug drawing of the electrolyte samples, servicing and checking of the electrolyte level shall be possible.



NOTE 1 — Aluminium used in the manufacture of the intercell connectors shall conform to IS : 737-1965* IS designation S1B or S1C.

NOTE 2 — Cell connector before lead coating to be in '0' condition as specified in 'bend test' of **10.3.2** of IS : 737-1965*.

NOTE 3 — Lead coating thickness shall be measured in accordance with Appendix F.

NOTE 4 — Each pair of intercell connectors shall be used in conjunction with fastener for cell connector (see Fig. 2B).

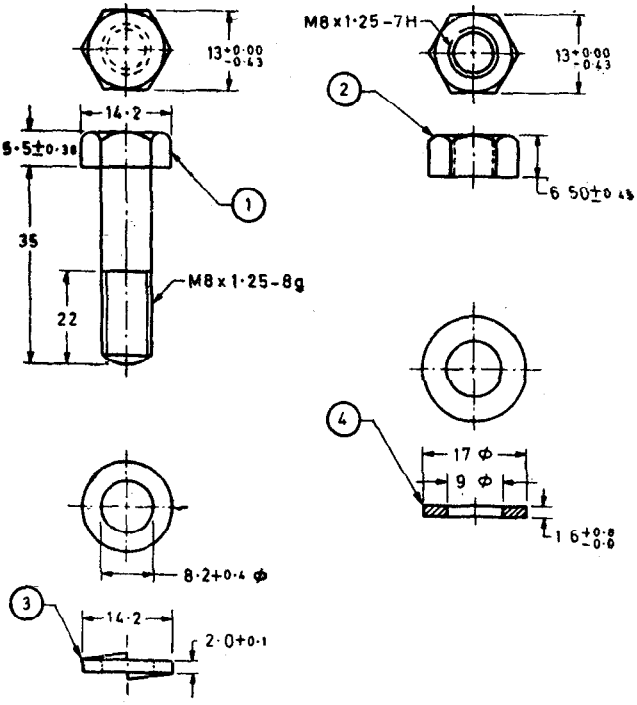
NOTE 5 — Edges should be free from burrs.

*Specification for wrought aluminium and aluminium alloys, sheet and strip (for general engineering purposes) (*revised*).

All dimensions in millimetres.

2A Lead Coated Intercell Connectors

FIG. 2 INTERCELL CONNECTORS AND FASTENERS — *Contd*



Part No.	*Description*	*No. of Intercell Connector*	*No. of End-cell Connector*	*Material Specification*	*Material*	*Dimensional Specification*
1	Hex. Bolt M8 × 35 — IS : 1363	4	2	IS : 1367-1967*	Free cutting steel	IS : 1363-1967†
2	Hex. Nut M8 — IS : 1363	4	—	IS : 1367-1967*	Free cutting steel	IS : 1363-1967†
3	Spring Washer M8 — IS : 3063	4	2	IS : 4072-1975‡	Spring steel or EN 42 steel	IS : 3063-1972§
4	Punched Washer as IS : 2016, steel	8	2	IS : 4030-1973‖	Cold rolled steel, dead soft	IS : 2016-1967¶

NOTE 1 — Thickness of lead coating of components shall not be less than 0·025 mm. After lead coating threads of nut and bolt shall not transgress the maximum material limits for position *H* or *h* referred in IS : 4218-1967**.

NOTE 2 — Lead coating thickness should be measured as per Appendix F.

*Technical supply conditions for threaded fasteners (*first revision*).

†Specification for black hexagon bolts, nuts and lock nuts (dia 6 to 39 mm) and black hexagon screws (dia 6 to 24 mm) (*first revision*).

‡Specification for steel for spring washers (*first revision*).

§Specification for single coil rectangular section spring washers for bolts, nuts and screws (*first revision*).

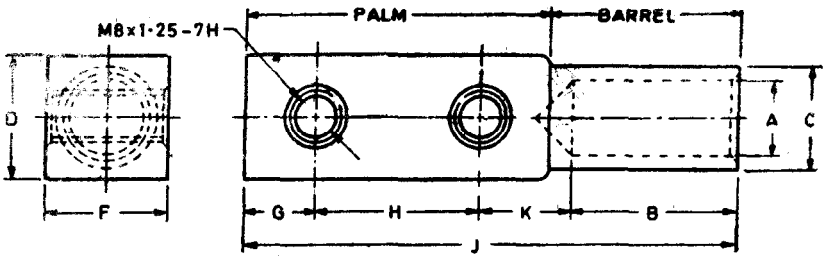
‖Specification for cold rolled carbon steel strip for general engineering purposes (*first revision*).

¶Specification for plain washers (*first revision*).

**ISO metric screw threads.

2B Fastener for Intercell Connectors and End-cell Connectors

FIG. 2 INTERCELL CONNECTORS AND FASTENERS



Battery Capacity AH	*Polarity*	*Area of Cross Section* mm²	*Cable*	*Dia* ±0·13	*Dia* ±0·13	*D* ±0·9	*F* ±0·5	*B*	*K*	*H* ±0·5	*G*	*J* ±1
800 & 350	Positive	133	810/·45	17·2	22·0	26·5	26·5	33·5	14·6	25·4	11	84·5
800 & 350	Negative	133	810/·45	17·2	22·0	26·5	26·5	33·5	17·8	22·2	11	84·5
125 & 210	Positive	70	19/2·24	11·6	16	19	19	26	14·6	25·4	11	77
125 & 210	Negative	70	19/2·24	11·6	16	19	19	26	17·8	22·2	11	77
320, 400 &525	Positive	120	37/2·06	14·8	19·6	25	25	32	14·6	25·4	11	83
320, 400 &525	Negative	120	37/2·06	14·8	19·6	25	25	32	17·8	22·2	11	83

NOTE 1 — Thickness of lead coating of end-cell connector shall not be less than 0·025 mm. After lead coating, threads shall not transgress the maximum material limits for position *H* or *h* referred in IS : 4218-1967*.

NOTE 2 — Lead coating thickness shall be measured in accordance with Appendix E.

NOTE 3 — The end-cell connectors for 800 Ah and 350 Ah cells shall be of pure electrolytic copper in accordance with IS : 1897-1971†. Aluminium used for the manufacture of end-cell connectors for other ratings shall conform to IS : 5082-1969‡ Grade *E* 91 *E*.

NOTE 4 — Before lead coatings the copper connector shall be in bright annealed condition and the aluminium connector in '0' and 'H2' condition for the barrel and palm respectively.

NOTE 5 — Polarity, size of cable in mm² and maker's mark shall be punched on flat surface. Example: Negative 120 mm² maker.

NOTE 6 — Unless otherwise mentioned tolerance of ± 2·5 percent shall apply.

*ISO Metric screw threads.

†Copper strips for electrical purposes (*first revision*).

‡Wrought aluminium and aluminium alloys, bars, rods, tubes and sections for electrical purposes.

FIG. 3 LEAD-COATED END-CELL CONNECTOR (CRIMPING TYPE)

3.3.4.1 Where the venting system is incorporated in the float guide, filling plugs may be provided. The filler plugs on removal, shall permit servicing and checking of electrolyte.

3.3.5 *Sealing Compound* — Sealing compound, if bitumen based, shall conform to IS : 3116-1965*.

3.3.6 *Float Guide and Float* — The float guide shall be removable and of antisplash type, and shall facilitate unrestricted vertical movement of the float stem. The float stem shall have markings to indicate the lowest and highest electrolyte levels permissible. The float assembly shall be suitably designed to prevent acid splash in service.

3.4 Electrolyte

3.4.1 The electrolyte shall be prepared from battery grade sulphuric acid conforming to IS : 266-1961†.

3.4.2 The level of the electrolyte shall be that specified by the manufacturer and shall be at least 25 mm above the top edge of the separator.

3.4.3 Up to 525 Ah capacity cells the specific gravity of electrolyte when the battery is in fully charged condition at 27°C shall be between 1·210 and 1·220 and for cells with capacity higher than 525 Ah electrolyte specific gravity shall be between 1·245 and 1·255. The specific gravity shall be corrected to 27°C using the formula given under **3.2.2** of IS : 8320-1976‡.

3.4.3.1 After a full charge, the specific gravity and temperature of the electrolyte shall be measured and the specific gravity corrected to 27°C using the formula:

$$SG_{27} = SG_t + 0{\cdot}000\,7\,(t - 27)$$

where

SG_{27} = specific gravity at 27°C,

SG_t = specific gravity at t°C, and

t = temperature of the electrolyte (*see* **5.4.6**).

3.5 Water — Water intended for storage batteries, conforming to IS : 1069-1964§, shall be added to bring the level of electrolyte to approximately the correct height during the course of testing except when specifically stated otherwise. It shall be added just before the charge or during early part of the charge so that gassing will thoroughly mix it with the electrolyte.

*Specification for sealing compound for lead-acid batteries.

†Specification for sulphuric acid (*revised*).

‡General requirements and methods of tests for lead-acid storage batteries.

§Specification for water for storage batteries (*revised*).

3.6 Separators — Separators shall be of microporus rubber, plastic or any other material conforming to relevant Indian Standards (*see* IS : 6071-1970*).

4. RATING

4.1 The rating assigned to the cell or battery shall be the capacity (C 10) expressed in ampere-hours (after correction to 27°C) stated by the manufacturer to be obtainable when the cell or battery is discharged at the 10-h rate to the end voltage of 1·80 volts per cell.

4.2 Service Conditions — The cells are required to work at ambient temperatures up to 50°C and will be subjected to vibration and dust in service when installed in the battery boxes suspended from the underframe of the coaches. The vibration is assumed to be of sine-wave form with frequency between 1 Hz to 50 Hz. The amplitude of vibration in mm is $\frac{25}{f}$ for values of from 1 Hz to 10 Hz and $\frac{250}{f^2}$ for values of f exceeding 10 Hz and up to 50 Hz. The stresses due to sudden variations in vehicle speed and track conditions will correspond to $\pm 3g$ (g being the value of acceleration due to gravity). The design and the construction of the cells shall be suitable to withstand the above service conditions.

4.3 The manufacturer shall declare the maximum electrolyte temperature permissible for continuous and for short duration of 2 hour operation.

5. TESTS AND PERFORMANCE

5.1 Classification of Tests

5.1.1 *Type Tests* — The following shall constitute the type tests:

a) Capacity at 10-h rate (**5.4**);
b) Capacity at 5-h rate (**5.5**);
c) Capacity at 3-h rate (**5.6**);
d) Watt-hour and ampere-hour efficiency tests (**5.7**);
e) Retention of charge (**5.8**);
f) Life test (**5.9**);
g) Storage test (**5.10**);
h) Air pressure test (**5.11**);
j) Vibration test (**5.12**);
k) Electrolyte temperature-rise test (**5.13**);

*Specification for synthetic separators for lead-acid batteries.

m) Checking of dimensions, mass, markings and workmanship (**5.14**); and

n) Material and component specification verification test (**5.15**).

5.1.1.1 *Sequence of type tests* — The sequence of type tests and the number of samples required shall be in accordance with Appendix D.

5.1.1.2 If any of the samples fails in the relevant type test, the testing authority may call for fresh samples not exceeding twice the original number of cells tested in that particular test and subject them again to the test(s) in which failure occurred. If there is any failure in the retest(s), the type shall be considered as not having passed the requirements of this standard.

5.1.2 *Acceptance Test*

5.1.2.1 The acceptance tests shall be applied on two samples up to a maximum of 1 percent of each type in a lot, the samples being drawn at random by the purchasing or the inspecting authority.

5.1.2.2 The following test shall be conducted as acceptance tests:

a) Capacity test at 10-h rate (**5.4**), and

b) Checking of dimensions, mass, markings and workmanship (**5.14**).

5.1.2.3 *Criteria for acceptance* — If any of the sample batteries fails in any of the acceptance tests, twice the original number of samples shall be taken and subjected to all the acceptance tests. If there is any failure in the retests the lot may be rejected.

5.2 Test Equipment — The voltmeters, ammeters, thermometers and hydrometers required for the tests specified in this standard shall meet the requirements given in **5.2** of IS : 8320-1976*.

5.3 Temperature for Test — Unless otherwise specified the temperature for tests shall be between 20 and 30°C.

5.4 Test for Capacity at 10-h Rate

5.4.1 After standing on open circuit for neither less than 12 hours nor more than 24 hours from the completion of a full charge, the battery shall be discharged through a suitable resistance at a constant current $I = 0{\cdot}10 \times C_{10}$ amperes, and the discharge shall be stopped when the closed circuit voltage across the battery terminals fall to 1·80 volts per cell.

5.4.2 At this rate of discharge, hourly voltage readings may be taken until the battery voltage approaches 1·90 volts per cell after which the readings shall be taken every 15 minutes until the voltage falls to 1·80 volts per cell.

*General requirements and methods of test for lead-acid storage batteries.

5.4.3 The average temperature of the electrolyte taken hourly shall be taken as temperature t°C of the electrolyte during discharge.

5.4.4 On the first discharge, the battery or cell shall give not less than 85 percent of the rated capacity, and the rated capacity shall be reached within 10 disharge cycles subsequent to the initial charge.

NOTE — If as a result of the first test itself the capacity is found to be equal to or above the rated value, it is not necessary to carry out further tests.

5.4.5 The battery shall be charged at the normal charging rate immediately after the discharge.

5.4.6 The capacity in ampere-hours shall be obtained by multiplying the discharge current by the total time of discharge in hours and the product so obtained shall be corrected to a temperature of 27°C by the following formula:

$$C_{27} = \frac{C_t}{1 + K(t - 27)}$$

where

C_{27} = ampere-hour capacity at an average electrolyte temperature of 27°C,

C_t = ampere-hour capacity obtained at an average electrolyte temperature of t°C,

K = correction factor which is equal to 0·0043 for both tubular positive plates and pasted plates, and

t = average temperature of electrolyte during discharge (mean value of initial and final temperatures).

5.4.7 The capacity at 10-h rate when tested as in **5.4.6** shall be not less than the rated capacity (C_{10}) (*see* Table 1).

5.5 Test for Capacity at 5-h Rate

5.5.1 After standing on open circuit for not less than 12 hours but not more than 24 hours from the completion of a full charge, the battery shall be discharged through a suitable resistance at a constant current $I = 0{\cdot}2\ C_5$ A where $C_5 = 0{\cdot}83\ C_{10}$ and the discharge shall be stopped when the closed circuit voltage across the battery terminals falls to 1·75 V per cell.

5.5.2 At this rate of discharge, hourly voltage readings may be taken until the battery voltage approaches 1·9 V per cell after which the readings shall be taken every 15 min until the voltage falls to 1·75 V per cell.

5.5.3 The average temperature of electrolyte taken hourly shall be taken as temperature t°C of the electrolyte during discharge.

5.5.4 The battery shall be charged at the normal charging rate immediately after the discharge.

5.5.5 The capacity in ampere-hours shall be obtained by multiplying the discharge current by the total time of discharge in hours and the product so obtained shall be corrected to a temperature of 27°C by the formula given under **A-5** of IS : 8320-1976*. The following shall be the values of K:

$K = 0{\cdot}005\ 8$ for tubular plate

$= 0{\cdot}008\ 4$ for pasted plate.

5.5.6 The capacity at 5-h rate when tested as above shall not be less than 83 percent of the rated capacity.

5.6 Test for Capacity at 3-h Rate

5.6.1 After standing on open circuit for not less than 12 hours but not more than 24 hours from the completion of a full charge, the battery shall be discharged through a suitable resistance at a constant current $I = 0{\cdot}33\ C_3$ A where $C_3 = 0{\cdot}72\ C_{10}$ and the discharge shall be stopped when the closed circuit voltage across the battery terminals falls to 1·70 V per cell.

5.6.2 At this rate of discharge, hourly voltage, readings may be taken until the battery voltage approaches 1·9 V per cell after which the readings shall be taken every 15 min until the voltage falls to 1·70 V per cell.

5.6.3 The average temperature of electrolyte taken hourly shall be taken as temperature t°C of the electrolyte during discharge.

5.6.4 The battery shall be charged at the normal charging rate immediately after the discharge.

5.6.5 The capacity in ampere-hours shall be obtained by multiplying the discharge current by the total time of discharge in hours and the product so obtained shall be corrected to a temperature of 27°C by the formula referred in **5.5.5** with the following values of correction factor K:

$K = 0{\cdot}006\ 8$ for tubular plates

$= 0{\cdot}009\ 1$ for pasted plates.

5.6.6 The capacity at 3-h rate when tested as above shall be not less than 72 percent of the rated capacity.

5.7 Watt-Hour and Ampere-Hour Efficiency Test — Watt-hour and ampere-hour efficiencies when tested and calculated as described in Appendix E shall be not less than 75 percent and 90 percent respectively.

5.8 Test for Retention of Charge — The object of this test is to determine the loss of capacity of a battery on open circuit during a specified period.

*General requirements and methods of test for lead-acid storage batteries.

5.8.1 The battery shall be fully charged at the current specified by the manufacturer and it shall then be submitted to two consecutive capacity test in accordance with **5.4**, the value of initial capacity C being calculated as the mean of the two results thus obtained.

5.8.2 After a complete recharge and after cleaning of the electrolyte from its surface, the battery shall be left on open circuit for a period of 14 days without disturbance at a temperature of 27 ± 2°C.

5.8.3 After 14 days storage the battery shall be discharged in accordance with **5.4**. The value of capacity measured after storage shall be denoted by C_1.

5.8.4 After discharge the battery shall be fully charged at the rate recommended by the manufacturer.

5.8.5 The loss of capacity S expressed as a percentage shall be calculated from the formula:

$$S = \frac{C - C_1}{C} \times 100$$

5.8.6 *Requirement* — When tested in accordance with the method specified above, the loss of capacity shall not be more than 10 percent of the initial capacity.

5.9 Life Test

5.9.1 The life of battery is defined by the number of life test units obtained under the following conditions.

5.9.2 The life test is carried out on at least three cells which have satisfactorily passed the tests in accordance with **3.1**, **5.4** and **5.14**.

5.9.3 The battery is to be fully charged. When fully charged, the level and the specific gravity of the electrolyte of each battery shall be checked and, if necessary, adjusted.

5.9.4 *Test Capacity*

5.9.4.1 The battery shall be kept in an air chamber (*see* Note under **5.9.5**) the temperature of which is maintained at 50 ± 2°C. If, however, several cells are placed in the same chamber, a minimum distance of 25 mm shall be maintained between them. The minimum distance between the cells and the sides of the air chamber shall also be 25 mm.

5.9.4.2 After standing on open circuit for not less than 12 hours but not more than 24 hours from the completion of a full charge, the battery shall be discharged through a suitable resistance at a constant current $I = 0{\cdot}10 \times C_{10}$ A and the discharge shall be complete when the closed circuit voltage across the battery terminal falls to 1·80 V per cell.

5.9.4.3 At this rate of discharge hourly voltage reading may be taken until battery voltage reaches 1·9 V per cell, after which the reading shall be taken every 15 minutes until voltage falls to 1·80 V per cell.

5.9.4.4 The capacity in Ah shall be obtained by multiplying the discharge current by the total time of discharge in hours. This capacity shall be called as original test capacity.

5.9.4.5 The battery shall be charged at the normal charging rate immediately after the discharge.

5.9.5 The batteries shall then be subjected to a series of discharges and charges continuously. The dischage shall be for 4 hours at a current of $I = 0{\cdot}25\ C_{10}$ A. This shall be followed by charge at a current of $I = 0{\cdot}25\ C_{10}$ A for 20 hours.

During the discharging and charging periods, the batteries shall be kept in an air chamber (*see* Note) the temperature of which is maintained at 50 ± 2°C. If several batteries are placed in the same chamber, a minimum distance of 25 mm shall be maintained between them. The minimum distance between the batteries and the sides of the air chamber shall also be 25 mm. Distilled or de-ionized water shall be added to the cells daily during the life test to maintain the electrolyte at its normal level. The discharge and charge cycles shall be carried out five times.

NOTE — Until the air chamber facilities are available with the manufacturers, the test may be carried out in a water-bath whose temperature is maintained at 50 ±2°C.

5.9.6 After the above cycles of discharges and charges the batteries shall be kept on open circuit for 24 hours at 50 ± 2°C. After this open circuit stand, they shall be test discharged at a rate of $0{\cdot}1\ C_{10}$ A. The discharge is continued to an end voltage of 1·80 V per cell. On completion of this discharge the battery shall be fully recharged. The combination of discharge and recharge cycles as described above together with 24-hours open-circuit stand period, the test discharge and subsequent recharge shall be one unit of life test.

5.9.7 The battery shall be subjected to repeated test units of life test as described in **5.9.6**, until the capacity measured in any test discharge falls to 80 percent of the original tested capacity. The number of life units the battery has exhibited shall be recorded.

NOTE — The value of percentage of original tested capacity after which the life test shall be stopped will be reviewed later when more information is available.

5.9.8 The number of life units is under consideration.

NOTE — Till such time the minimum number of life units is incorporated in the standard, such a requirement shall be subject to agreement between the manufacturer and the purchaser.

5.10 Storage Test — The batteries shall be capable of being stored unfilled, for a period of 24 months.

5.10.1 After storage for the specified period, the batteries shall be tested for capacity at the 10-h rate and shall satisfy the requirements given in **5.4**.

5.11 Air Pressure Test (for Leakage) — The sealing of each cell of the battery shall be checked by compressed air at a pressure equal to 70 cm H_2O. The volume of the tubes and auxiliary parts connected to the cell under pressure shall not no exceed 0·5 litre. The air pressure in the cell, 15 seconds after supply has been disconnected, shall be noted.

5.11.1 The air pressure shall not fall from 70 cm H_2O to below 67 cm H_2O within 15 seconds after the supply of compressed air has been discontinued. The cell lid shall not show any visible sign of movement due to the air pressure.

NOTE — This test shall be carried out on unfilled cells.

5.12 Vibration Test — Under consideration.

5.13 Electrolytic Temperature-Rise Test — Under consideration.

5.14 Checking of Dimensions, Mass, Markings and Workmanship — The cells shall be checked to see that the dimensions and masses conform to **3.1** and the marking is according to **6.1**. The cells shall be visually examined for the following:

a) Appearance of the container, that is, watch for cracking or chipping or distortion;

b) Signs of leakage or spillage; and

c) Appropriate marking on the battery.

5.15 Material and Component Specification Verification Test — The cell shall be examined in the dismantled condition to see that the manufacture is to the approved outline and assembly drawing and the various components are conforming to the specification as detailed in this standard and/or declared by the manufacturer. The samples of sealing compound, separator, container and electrolyte shall be taken at random from the manufacturing line and tested to see that they meet the requirements of the relevant specifications.

6. MARKING AND PACKING

6.1 Marking — Both the shorter sides of each cell shall have the following details marked on it:

a) Manufacturer's name or trade-mark,

b) Rating at 10-hour discharge rate, and

c) Specific gravity of the electrolyte in the fully charged condition at 27 $\pm$ 2°C.

6.1.1 The year and month of manufacture shall be punched on the terminal lug base.

6.1.2 The batteries may also be marked with the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

6.2 The batteries shall be suitably packed so as to avoid any loss or damage during transit.

7. MANUAL OF INSTRUCTIONS

7.1 The manufacturer shall supply one copy of instruction manual for initial treatment and routine maintenance on service, with every batch of batteries ordered.

APPENDIX A

(*Clause* 0.5)

SCHEDULE OF DESIGN PARTICULARS

The following particulars are required to be supplied by the manufacturer with the quotation:

Sl No.	*Description*	*Particulars to be filled in*
1.	Make	.....
2.	Type of unit	.....
3.	Manufacturer's nomenclature	.....
4.	Overall dimensions of unit (length × width × height)	..... mm
5.	Mass per unit with acid	.....kg
6.	Cell container material	.....
7.	Type of positive plates	.....
8.	Type of negative plates	.....
9.	Separators	.....

Sl No.	*Description*	*Particulars to be filled in*
10.	Maximum electrolyte temperature that the cell/battery withstand without any damage:	
	a) continuously	.....°C
	b) for a short period	.....°C
11.	Electrolyte height above the top of the separators	..... mm
12.	Electrolyte height below the bottom plates	..... mm
13.	Quantity of electrolyte per cell	.....litres
14.	Specific gravity of electrolyte for initial filling at 27°C	.....
15.	Details of initial treatment recommended	.....
16.	Material of terminal and intercell connectors	.....
17.	Normal charging rate	..... A

APPENDIX B

(*Clause* 0.5)

SCHEDULE OF PERFORMANCE

Sl No.	*Description*	*Particulars to be filled in*
0.	Batteries offered according to this standard shall be covered by a type approval certificate from an appropriate authority. All variations in design shall be covered by a separate type approval certificate. Following particulars regarding the type tests shall be supplied by the manufacturer along with the certificate against any quotation or tender.	
1.	Ampere-hour capacity (*see* **5.4**)	.....ampere-hour
2.	Retention of charge	.....percent

Sl No.	*Description*	*Particulars to be filled in*
3.	Resistance to overcharge	.....hours
4.	Life	.....cycles
5.	Storage	.....ampere-hour
6.	Ampere-hour efficiency (*see* **5.7**)	.....percent
7.	Watt-hour efficiency (*see* **5.7**)	.....percent
8.	Rise in electrolyte temperature above the ambient air temperature when charged from fully discharged to fully charged condition at normal rate	.....°C
9.	Charge and discharge curves with voltage *versus* time showing the performance of the cell for discharge at 10-h rate and charge at normal rate	.....
10.	Recommendations for a reasonably fast charging method without affecting the manufacturer's guarantee	.....

APPENDIX C

(*Clause* 0.6)

SERVICE TESTS

C-1. SERVICE TESTS

C-1.1 On completion of actual service of one year the capacity of battery when tested in the manner prescribed in **5.4** shall be not less than the rated capacity when corrected to standard temperature.

C-1.2 On completion of a minimum of two years actual service but not exceeding 28 months commencing from the date of supply, the capacity of the batteries, when tested in the manner prescribed in **5.4** shall be not less than 90 percent of the rated capacity.

C-1.3 If any of the cells fails to comply with the tests as prescribed above these shall be considered as failure. The terms for replacement shall be as agreed between the manufacturer and the purchaser.

APPENDIX D

(*Clause* 5.1.1.1)

SEQUENCE OF TYPE TESTS

Test	*Sample Number*								
	1	2	3	4	5	6	7	8	9
*a) Checking of dimensions, mass, markings and workmanship	×	×	×	×	×	×	×	×	×
b) Capacity at 10-h rate	×	×	×	×	×	×	×	—	—
c) Material and component specification verification test	—	—	—	—	—	—	—	—	×
d) Air pressure	—	—	—	—	—	—	—	×	×
e) Storage	—	—	—	—	—	—	—	×	×
f) Vibration	×	×	—	—	—	—	—	—	—
g) Life	—	—	×	×	×	—	—	—	—
h) Watt-hour and ampere-hour efficiencies	—	—	—	—	—	×	×	—	—
j) Capacity at 5-h rate	—	—	—	—	—	×	×	—	—
k) Capacity at 3-h rate	—	—	—	—	—	×	×	—	—
m) Retention of charge	—	—	—	—	—	×	×	—	—
n) Electrolyte temperature rise	—	—	—	—	—	×	×	—	—

APPENDIX E

(*Clause* 5.7)

WATT-HOUR AND AMPERE-HOUR EFFICIENCY TEST

E-1. TEST OF WATT-HOUR AND AMPERE-HOUR EFFICIENCY

E-1.1 Ampere-Hour Efficiency — A fully charged battery shall be discharged at $I = 0{\cdot}1 \times C_{10}$ A to an end voltage of $1{\cdot}8 \times n$ volts, careful measurements being made of the exact number of ampere-hours delivered. On recharge the same number of ampere-hours are put back at the same current. A second discharge shall then be made to the same cut-off voltage as before. The efficiency of the battery is then calculated as the

*Mass to be checked only for sample numbers 1 to 7.

ratio of the ampere-hour delivered during the second discharge to the ampere-hour put in on the charge.

E-1.2 Watt-Hour Efficiency — The watt-hour efficiency shall be calculated by multiplying the ampere-hour efficiency by the ratio of average discharge and recharge voltage. The values of discharge and recharge voltages shall be calculated from the log sheets for ampere-hour efficiency.

APPENDIX F

(*Fig.* 2A, 2B *and* 3)

DETERMINATION OF LEAD COATING ON ALUMINIUM AND STEEL

F-1. DETERMINATION OF THICKNESS OF LEAD COATING BY QUANTITATIVE STRIPPING

F-1.1 The average thickness of lead coating on intercell connectors, end-cell connectors of fasteners shall be determined by quantitative stripping.

F-1.2 The specimen shall be weighed to the nearest milligram.

F-1.3 The lead plating on the specimen shall be dissolved in a mixture of 80 percent acetic acid and 5 to 10 percent (by volume) hydrogen peroxide at a temperature of 60°C approximately till the base metal is observed visually.

F-1.4 The specimen shall be rinsed in water and then in alcohol and dried between sheets of filter paper. It shall then be weighed to the nearest milligram.

F-1.5 By means of vernier callipers and micrometer, measurements are taken and area of surface on which the coating of lead was applied shall be calculated.

F-1.6 The average thickness of lead coating (in cm) on the specimen tested is given by the following formula:

$$\frac{\text{Loss in mass (in grams)}}{11{\cdot}34 \times \text{Area of specimen (in cm}^2\text{)}}$$

F-2. DETERMINATION OF THICKNESS OF LEAD COATING BY USE OF THICKNESS GAUGES

F-2.1 For parts made of aluminium, an eddy current thickness gauge may be used alternative to the method specified in **F-1** to determine the local thickness of lead on aluminium.

F-2.2 For parts made of steel, magnetic thickness gauge may be used alternative to the method specified in **F-1** to determine the local thickness of lead on steel.

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AMENDMENT NO. 1 APRIL 1985

TO

IS : 6848-1979 SPECIFICATION FOR LEAD-ACID BATTERIES FOR TRAIN LIGHTING AND AIRCONDITIONING SERVICES

(First Revision)

(*Page* 5, *Table* 1, *Sl No.* 7) — Delete together with all entries against it.

(*Page* 8, *Fig.* 2, *Note* 1) — Substitute ' 0·01 mm ' *for* ' 0·025 mm '.

(*Page* 12, *clause* **5.1.2**) — Substitute the following for the existing clause:

'**5.1.2** *Acceptance Test* — The following tests shall be conducted as acceptance tests:

a) Capacity test at 10 h rate (**5.4**), and

b) Checking of dimensions, mass, markings and workmanship (**5.14**).

(*Page* 12, *clause* **5.1.2**) — Add the following new clause after **5.1.2** :

'**5.1.3** *Sampling Scheme and Criteria for Acceptance*

5.1.3.1 A recommended sampling scheme and criteria for the acceptance of the lot for various lot sizes is given in Appendix G. '

(*Page* 12, *clause* **5.2**) — Add the following at the end of the clause:

'Use of a digital ammeter/voltmeter is preferable for testing. Chart recorders shall be used for life cycle testing. '

(*Page* 16, *clause* **5.9.8**) — Substitute the following for the existing matter:

'**5.9.8** The number of life units shall not be less than 6. '

(*Page* 21, *Appendix* D) — Add the following Note after sequence of type tests:

'NOTE — The cell shall be covered by type approval certificates from an appropriate authority. Significant variations in the design shall be covered by separate type approval certificates. The cell of new design shall be proto-type tested for which samples offered by the manufacturer shall be accepted. For type test samples drawn from mass production at random shall be retested after 5 years. In case of unsatisfactory performance of cells, type testing can be repeated earlier at the discretion of the approving authority. '

(*Page* 22, *Appendix* F) — Add the following as Appendix G after Appendix F:

APPENDIX G

(*Clause* 5.1.3.1)

SAMPLING SCHEME AND CRITERIA FOR CONFORMITY FOR ACCEPTANCE TESTS

G-1. LOT

G-1.1 All the batteries of the same type, design and rating manufactured from the same material by the same factory under similar conditions of production shall constitute a lot.

G-1.2 The batteries to be selected from each lot shall depend upon the size of the lot and shall be in accordance with col (1) and (2) of Table 2:

TABLE 2 SAMPLE SIZE, ACCEPTANCE AND REJECTION NUMBERS

(*Clauses* G-1.2 *and* G-2.1)

Lot Size	First Stage	Second Stage		Acceptance Number	First Rejection Number	Second Rejection Number
(N)	(n)	(n)	($2n$)	(a)	(r_1)	(r_2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Up to 50	2	—	2	0	1	—
51 „ 300	3	—	3	0	1	—
301 „ 500	5	5	10	0	2	2
501 „ 1 000	8	8	16	0	2	2
1 001 and above	13	13	26	0	3	4

Note 1 — The sampling plan given in the table envisages that the lots containing about 4 percent defective batteries will be accepted most of the time.

Note 2 — For lots of size up to 300, the decision regarding acceptance or rejection of the lots shall be taken at the first stage only.

G-1.2.1 These batteries shall be selected from the lot at random. In order to ensure the randomness of selection, procedures given in IS : 4905-1968* may be followed.

G-2. NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

G-2.1 All the batteries selected at the first stage in accordance with col (1) and (2) of Table 2 shall be subjected to the acceptance tests.

*Methods for random sampling.

A battery failing to satisfy the requirements of any one of the acceptance tests shall be termed as defective. The lot shall be considered as conforming to the requirements of acceptance tests if no defective is found and shall be considered as non-conforming to the requirements if the number of defectives is equal to or greater than the first rejection number (r_1). If the number of defectives is greater than the acceptance number (a) but less than the first rejection number (r_1), the second sample of the same size as taken in the first stage shall be selected from the lot at random and subjected to the acceptance tests. The number of defectives in the first sample and the second sample shall be combined. If the combined number of defectives is less than the second rejection number (r_2), the lot shall be considered as conforming to the requirements of acceptance tests; otherwise not.

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TO

IS:6848-1979 SPECIFICATION FOR LEAD-ACID BATTERIES FOR TRAIN LIGHTING AND AIRCONDITIONING SERVICES

(First Revision)

(*Page 22, Appendix F*) - Substitute the following for the existing Appendix:

A P P E N D I X F

(*Fig.* 2A, 2B *and* 3)

DETERMINATION OF AVERAGE THICKNESS OF LEAD-COATING (MODIFIED PROCEDURE FOR APPLICABILITY TO COPPER, AS ALUMINIUM CONDUCTOR CONNECTORS)

F-1. The lead plating on the specimen shall be dissolved in a mixture of 80 parts of glacial acetic acid, 10 parts of hydrogen peroxide, 30 percent and 10 parts of distilled water by volume at a temperature of 60°C approx. till the base material is observed visually.

F-2. Remove the specimen and wash it with distilled water. Collect the washings. To the solution of hydrogen peroxide, glacial acetic acid and add dilute sulphuric acid (sp gr 1.200 approx) till lead (Pb) is completely precipitated as $PbSO_4$.

F-3. Allow the precipitate to stand at room temperature to settle down. Decant the supernatant liquid and then filter the precipitate through a previously weighed Wattman filter paper No. 1. Wash the precipitate with water containing (10 percent by volume) H_2SO_4 until free of soluble impurities and then with 50 percent alcohol solution to remove the free acid. Dry the precipitate to a constant weight and determine the average thickness as follows:

a) Average lead plating thickness (in cm) $= \dfrac{\text{Weight of ppt. of } PbSO_4 \text{ (gm)} \times \text{0.683 3 conversion factor}}{11.34 \text{ (Density of lead)} \times \text{Surface area of the specimen in cm}^2}$

b) Average lead-plating thickness in microns = Average Lead Plating Thickness in cm X 10

(ETDC 11)

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AMENDMENT NO. 3 JULY 1988

TO

IS:6848-1979 SPECIFICATION FOR LEAD-ACID BATTERIES FOR TRAIN LIGHTING AND AIRCONDITIONING SERVICES

(First Revision)

(Page 7, clause 3.3.4) - Add the following at the end:

'The vent plug and float guide dia for train lighting cells shall be 27 mm with pitch thread of 3 mm as per IS:4218-1976*. The central hole in float guide and vent plug shall be of 7 mm dia.'

(Page 10, clause 3.4.2) - Substitute the following for the existing clause:

'3.4.2 The height of electrolyte above the top of the separators in fully topped up conditions shall not be less than 40 mm.'

(Page 17, clause 5.12) - Substitute the following for the existing clause:

'5.12 Vibration Test - The test shall be performed in accordance with IS:2106(Part 16)-1971†. The samples shall be first tested for capacity test as per 5.4, before putting into vibration test. The test consists in vibrating the batteries at a frequency of 16 Hz with a total displacement of 5 mm for a period of 2 hours. During vibration the batteries shall be discharged at the 10 hour rate.

*ISO Metric screw threads.

†Vibration test.

5.12.1 Requirements - There shall not be any sudden drop, either in the current or voltage values and there shall be no spillage of electrolyte during the test.

(ETDC 11)

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